Space Weather Technical Forecast

Issued on Friday, 06 January 2023 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of X-class flares throughout. Chance of G1/Minor Geomagnetic Storm intervals today.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with frequent C-class flares, the largest a C6.8 flare observed peaking at 05/0913 UTC from AR3182, which is the largest on the visible disc and is currently classified as Eai/beta, but is likely to have a more complex magnetic structure, which will become more evident as the region continues to rotate onto the visible disc. There are five other regions on the visible disc, of which AR3177 (Hax/alpha) and AR3181 (Dao/beta-gamma) are the most likely to produce significant flares. This is despite the simple classification of AR3177, which has a history of producing large C-class flares. AR3183 (Dai/beta-gamma) rapidly developed through the period, with the remaining region AR3180 (Dso/beta-gamma) relatively small and apparently stable.

Solar Wind / Geomagnetic Activity: Solar winds, observed at L1 started at slow-ambient levels, but then jumped to slightly elevated, and briefly elevated levels, through the evening, peaking at 05/2055 UTC at 510 km/s. Through the morning the density was above average, peaking at 17 ppcc at 05/0322 UTC. Through rest of the day the density declined to below average levels. Total magnetic field strength initially exhibited residual signs of a CME passage that occurred on the 4th, with total magnetic field at strong levels with a maximum of 20nT at 05/0344UTC. Thereafter a gradually decline occurred, ending the day at weak levels. The north-south component Bz had a prolonged negative period from late morning to early evening, mostly at weak levels but occasionally becoming moderately negative, reaching -13nT at 05/1049UTC. Phi angle was negative (towards the Sun) throughout. Geomagnetic activity remained at Quiet to Unsettled levels (Kp 0-3). The solar wind environment indicated residual CME effects along with a likely connection to a HSS from either CH60 or CH61.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2MeV) has been at background to moderate levels, peaking at 214 pfu. The 24-hour integrated electron fluence remained below the Active threshold with a falling trend, reaching 2.67e6 integrated pfu by 06/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low to Moderate, with a chance of X-class flares through the forecast period, these most likely from AR3182.

Solar Wind / Geomagnetic Activity: The effects of a CME which arrived at Earth on 04 January are expected to continue to subside over the next 12 hours. A CME may glance Earth today, but with low confidence. A weak high speed stream, from either coronal hole 60 or 61 is likely to persist today, then declining thereafter. Geomagnetic activity is expected to be Quiet to Unsettled (Kp 2-3) today, with isolated Active (Kp 4) periods likely, and a slight chance of a

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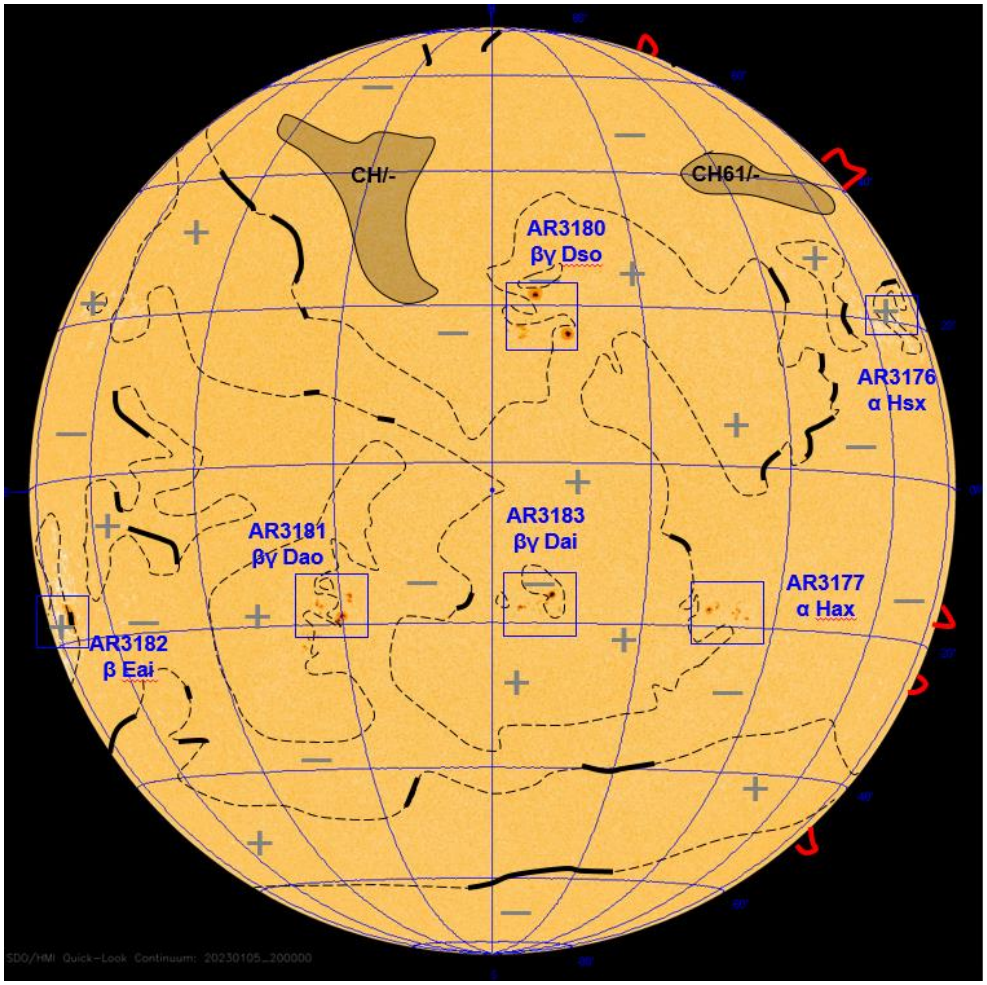
G1/minor geomagnetic storm (Kp 5). From tomorrow (7th) predominantly Quiet (Kp 0-2) conditions are expected.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is expected to remain at background levels throughout with a chance of rising alongside any notable flares, giving a slight chance of exceeding the S1/Minor Storm threshold. High energy electron flux (greater than 2MeV) levels are expected to be at background to moderate levels. Therefore the corresponding electron fluence values are forecast to remain below the Active (1e8 integrated pfu) levels, despite an increasing trend.

Figure 1. Solar Analysis Valid 05/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on 30 December impacted the Earth on 04 January, with the solar wind environment initially under the residual effects of this yesterday, but then late in the day a likely connection to a HSS appears to have occurred, either from CH60 or CH61. However, CH60 is no longer visible in SDO imagery and CH61 is now very faint. Therefore, the current HSS connection is expected to remain relatively weak, with speeds 450-500 km/s, and also brief. A glancing CME impact is possible today from a CME which left the Sun on 02 January, but this carries low confidence.

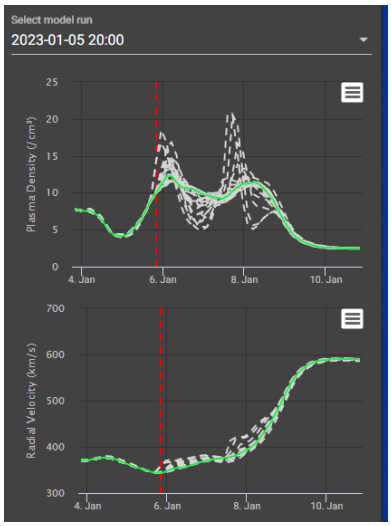
Geomagnetic activity is expected to be Quiet to Unsettled (Kp 2-3) today, with isolated Active (Kp 4) periods likely, and a slight chance of a G1/minor geomagnetic storm (Kp 5). From tomorrow (7th) predominantly Quiet conditions are expected.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
02/1454	Partial	Filament	SE	360	05/2000	Low confidence

Figure 2: Met Office Enlil ensemble, showing an indication of a CME arrival early today.



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Radio Blackouts - X-Ray Flares:

There are six sunspot regions on the visible disc. AR3182 remains the largest region and is currently classified as Eai/Beta, but may be classified as a beta-gamma once the region becomes clearer as it rotates further across the visible disc. Both AR3176 and AR3177 on the western hemisphere remain uni-polar, with AR3177 showing some slight decay in area. AR3180 is stable, the second largest region on the disc and remains classified as a beta-gamma. AR3181, in the southeast, continues gradual increase in the trailing spots. New region AR3183 emerged quite rapidly in the southern hemisphere during the previous 24 hours, with rudimentary penumbra now on a trailing spot, and is now classified as beta-gamma. AR3182 remains the most likely to produce a significant flare, and to a lesser extend AR3177 and AR3181, despite the simple classification of AR3177 which has a history of large C-class flares. Solar activity is likely to be Low to Moderate, with a chance of X-class flares. The probabilities of significant flares may increase further later in the period, as potentially new active regions could rotate onto the east limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	20	20	20	20

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 is at background levels. Any significant flares will bring a risk of proton flux rising at points during the period, with a slight chance of exceeding the S1/Minor Storm threshold. This risk increases slightly through the period, due mainly to the risk presented by AR3182 as it rotates further across the visible disc.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

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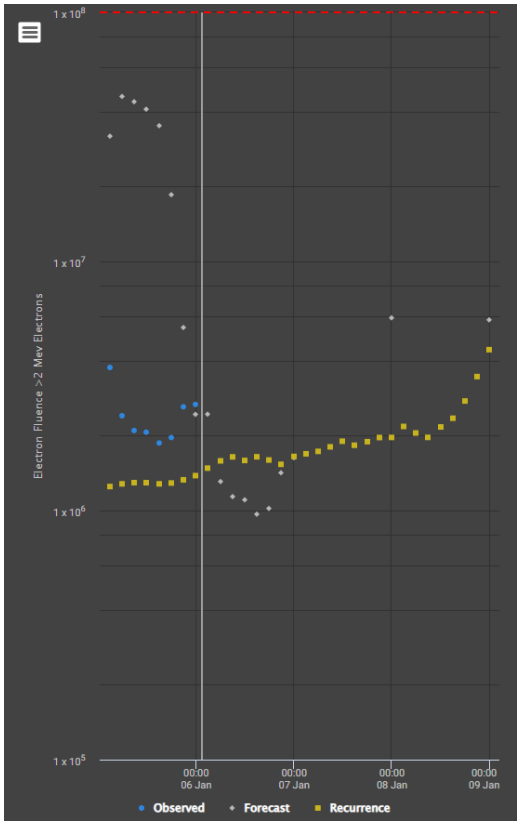
High energy electron flux (greater than 2MeV) has been at background to moderate levels. Despite the apparent connection to a high speed stream from either CH60 or CH61, as the connection is relatively weak so the high energy flux levels are expected to remain at background to moderate levels. The corresponding electron fluence values are forecast to remain below the Active (1e8 integrated pfu) levels, despite an increasing trend. The Met Office REFM model is therefore considered to be offering good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Met Office REFM model.



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